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GUIDELINES FOR THE CALCULATION OF THE COMPARATIVE COSTS OF ANIMAL PROTEIN IN DEVELOPING COUNTRIES

by

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1. INTRODUCTION

This paper is a shortened and adapted version of a study prepared in Poland by Michal Domagala and Krzysztof Jaworski in consultation with Ireneusz Wrześniewski. These authors were requested to study the Polish methods of analysing comparative production costs of animal protein from different sources (for example from fish, poultry or pigs) and to develop a guide method of analysis suitable for use in developing countries.

Polish fisheries economists have developed a thorough and detailed method of analysing the cost components of different types of animal protein based on data from a highly organized and integrated fishing industry. This approach is made possible because the industry is subject to a high degree of centralized planning and control. It was apparent to the authors that data in the quantity and of the quality available in Poland would not be available in most developing countries, and that the approach to be adopted in Third World countries would need to be much simpler (with some unavoidable loss of accuracy).

The authors concluded that the best solution to the difficulty was to provide precalculated tables for conversion of units of animal protein products to a common denomination of protein value, and to provide guidelines to analysts undertaking such studies.

This paper is intented only as a working document for use by those wishing to undertake economic studies of protein production in developing countries, and it is hoped that this approach will be refined and improved with the benefit of results from actual studies in developing countries.

2. OBJECTIVES

The availability of high protein food is a subject of great concern in many Third World countries. Whether the problem be a shortage of food in general or a specific protein shortage, decision makers and planners need to be aware, not only of the cost of the different types of high protein food, but of the comparative cost of producing protein by different means: by fishing, rearing pigs, etc. Thus a common measure of protein value is required so that a given quantity of an end product may be converted to its equivalent in protein units. With the benefit of such a measure of protein (for example catching fish, animal rearing, processing, packaging, spoilage, transportation, etc.) may be analyzed and compared at different stages from production through to final consumption. A development programme may then be geared to take into account the most

efficient way of producing protein and to increasing efficiency in general. Of course, such an approach needs to be undertaken with caution since consumer awareness of the protein "value for money" of different products may not be very great, resulting in consumer acceptance problems. Moreover, consumer tastes in high protein food may be highly traditional, making it difficult, for example, for new fisheries projects to be a success in countries where fish is not a traditional food. Nevertheless, comparative cost analysis of alternative protein sources can be highly relevant to the planning process, especially where considerations of protein availability outweigh those of consumer preference, and is of particular relevance in the fisheries sector, the importance of which is so often underestimated. There can be no doubt that fish is frequently undervalued as a low cost source of animal protein, even in countries where malnutrition is a tragic (but often unrecognized and unquantified) drain on a nation's scarce economic resources.

3. SECTOR ANALYSIS

Comparisons of production costs for protein can be made at various levels of each industry or sector. It is normally convenient to consider three levels:

I	Primary (Production) :	Fishing, animal production, etc.
II	Secondary (Processing):	Removal of inedible parts, packaging, presentation, etc.
III	Tertiary (Marketing) :	Storage, transportation, retailing, etc.

It might in some cases be considered useful to know the comparative protein costs at the end of the primary stage, for example, in countries where the secondary and tertiary stages are very rarely developed and/or in a rural society. In most cases, however, it is preferable to conduct the analysis at the level of final consumption. This requires more elaborate analysis. In order to know the quantity (weight) of the final product, it is necessary to know the reduction at each stage due both to spoilage and to processing, in addition to being able to convert weight of product into weight of protein. The spoilage rates and technical conversion factors in any processing activity will need to be researched locally since they are likely to differ from country to country.

4. DEFINITION OF UNITS

The unit definitions of protein content which are used in Poland are equally applicable elsewhere. They are as follows:

- Edible Parts: The weight of raw material reduced by components unsuitable for human consumption (e.g. hide, bone, skin, viscera etc.).

- Edible Protein Parts (EPP): The weight of edible parts reduced by the weight of fats.

- Conventional Protein Units (CPU): The weight of product equivalent to the weight of pure animal protein contained.

- Economic Cost: The cost of production adjusted from market prices to true factor cost.

5. CONVERSION TABLES

The attached tables provide a means of converting weight of raw material to edible protein parts and to conventional protein units. Also provided are conversion rates for selected end products. More specifically the tables provide the following:

Appendix 1	Table 1	Conversion tables of raw material to edible protein parts and conventional protein units, by various categories of fish by region.
	Table 2	Calculation of EPP and CPU for cattle, goats, sheep, pigs, poultry, eggs and milk. (general table).
	Tables 3 and 4	Concern edible offal and fat content of cattle, goats and sheep for selected countries in Africa, Asia and South America.
	Tables 5 and 6	Concern edible offal and fat content of pigs, poultry, eggs and milk for selected countries in Africa, Asia and South America.
Appendix 2		
	Table 1	Conversion table of fish products to EPP and CPU as % of final product (general table).

Table 2 Conversion table of meat products to EPP and CPU as % of final product.

Table 3 Conversion table of milk and egg products to EPP and CPU as % of final product.

Table 4 Conversion table of poultry products to EPP and CPU as % of final product.

6. ECONOMIC ASPECTS OF COMPARATIVE COST CALCULATION

The precise method of calculating the comparative costs of protein production according to different types of high protein food may vary greatly according to the situation, and will depend on the purposes of the study, the availability of data, the budget, and the structure of the industry or industries involved.

The basic requirements are firstly to track through the production, processing and distribution stages of a product's progress towards becoming a consumer product, accounting for all weight losses due to processing and spoilage. Secondly, for the purposes of an economic analysis, as in the case of economic cost/benefit studies, it is also appropriate to adjust for taxes and subsidies (which are merely transfers within the economy and not true costs or benefits to the economy as a whole). In certain circumstances it may also be considered appropriate to shadow price labour and adjust foreign exchange cost elements where exchange rates or availability of foreign exchange are controlled. There is a large amount of literature on economic and social cost/benefit studies and the prefered method for adjusting cost elements in such studies will depend on the situation and the preferences of the analyst, but in principle any of the generally accepted methods (Little and Mirlees, Squire and Van der Tak, UNIDO, etc.) could be used for comparative protein cost studies. Most bilateral and multilateral lending agencies and donors have produced a manual on such analysis. It is important only that the methodology used be internally consistent and fully understood by the analyst. Before conducting such studies, the analyst should consult the relevant Central Planning Department to establish normal practices in the country concerned and to obtain guidance on any shadow pricing that might be considered appropriate, and the accepted practice of dealing with foreign exchange adjustments.

In their analysis the Polish authors have outlined two approaches to the calculation of costs of protein, a price based method and a cost based method. In the case of Poland it is possible to build up a detailed analysis of cost

components from the accounts and statistical returns of the (predominantly) public sector establishments engaged in the fish and livestock industries, so that a high degree of accuracy can be achieved in determining the overall costs of production. Realizing that this would not be possible in most Third World situations, the authors have also suggested that an alternative approach could be to collect price data at each stage of distribution (e.g. landed price, wholesale price of processed product, retail price, etc.) and using known costs of key inputs, in the sector concerned and the appropriate allowances for spoilage and weight loss in processing, an analysis comparable to that based on costs could be prepared.

In practice the two methods should yield the same results (often allowing for seasonal factors and temporary disturbances to prices), the differences merely relating to the direction from which the figures are tracked down; working back from market prices or building up from costs of raw materials, inputs and services. The method used will depend on the sources, quantity and quality of data available. Obviously in a centrally planned modern fishing industry such as that of Poland a cost based approach is preferable. Indeed, since prices are not necessarily related to the forces of supply and demand, actual prices could be misleading indicators of economic costs. Government intervention might well be conceived to alter the relative prices of food for reasons of long term social and economic policy. However, in the case of an artisanal fishery where conditions approach those of perfect competition, then the only feasible approach is to base the analysis primarily on collected market price data, hopefully augmented by costs and earnings surveys, with appropriate allowances for seasonal and local geographical factors.

In Poland, the analysts take care to remove all "profits" from their calculations. This practice stems from the nature of the Polish economy where, for ideological and terminological reasons, profit information is not usually available for State enterprises, at least not in a form which renders it comparable to profit as applicable to smaller private ventures (even those which are found within the Polish system). Thus all the Polish analysis systematically excludes profit from the cost analysis.

The term profit is the subject of much discussion, ideological debate and a fair amount of confusion among politicians, economists and social scientists of all persuasions. We are concerned here only with the practical issues of ensuring meaningful comparisons between the costs of different types of high protein food. In the case of small-scale fisheries the concept of "normal profit", as understood in the theory of perfect competition, is the most

relevant one. The normal profit would include returns to the proprietor/fisherman for his own labour, the personal capital he has invested, his management skills and the normal risks he takes. The latter are potentially considerable, for although in some years the return to a proprietor may be very high, and although there may be substantial variations in profit rates, between, say, a small-scale fisherman and a small-scale pastoralist, these differences should in the long-run reflect risks and differences in risks. Thus, profits should be included as a cost element. This is not to say that economic or social barriers to factor mobility (which would erode the validity of our assumption of perfect competition) do not exist in the Third World; it is merely that analyses of this kind have to be guided by broad principles and in the light of generally very poor data. Certainly in most instances, the exclusion of profits from an analysis of a traditional livestock or a fishery sector would imply elimination of a major element of cost, quite apart from the statistical problems it would create.

However, in many, if not most, Third World countries, the food production and processing industries contain both traditional and modern components. The modern components are often State owned, and as in Poland may as a matter of Government policy either be industrialized or be able to extract monopoly profits as a result of their status. In such cases it is essential to adjust the official prices for any elements of subsidy, i.e. the controlled price (if that magnitude is being used in the analysis) must be increased by the amount of the subsidy, which is of course, a cost to the economy. (Monopoly profits which represent the differences between hypothetical 'normal profits' revenues and actual revenues are also a cost to the economy.)

In summary, in the case of Third World countries it is recommended that profits usually be taken into account in the comparative analysis of costs of high protein foods. It may also be concluded that in the context of developing countries the practical business of data collection itself will take the form mainly of a market price approach in the case of the traditional sector, and of a cost based approach in the case of the modern sector. The analyst will tailor his/her approach to the situation pertaining to the country and may need to distinguish several sectors.

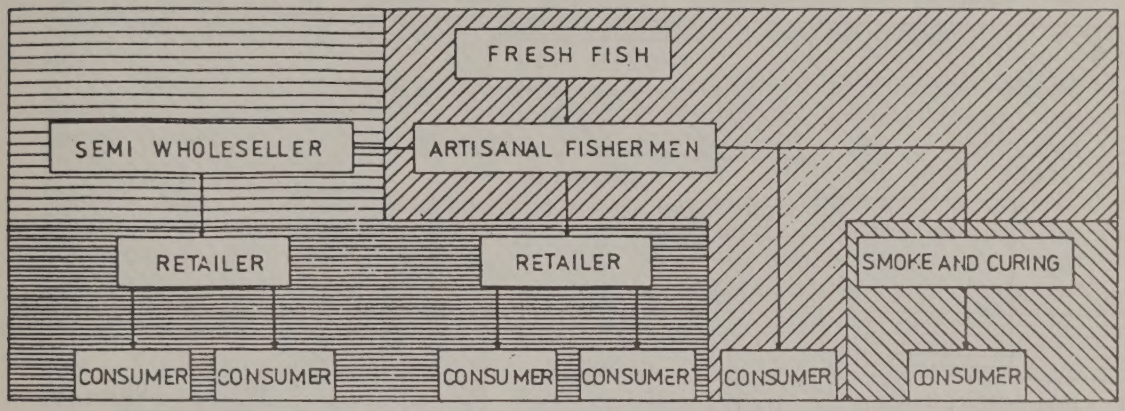
7. PRACTICAL STEPS

As a starting point it will probably be helpful to prepare a schematic presentation of the sectors or industries concerned. The diagrams on pages 7 and 8 illustrate a schematic view of the distribution patterns for fish in Senegal. The diagrams illustrate three sectors:

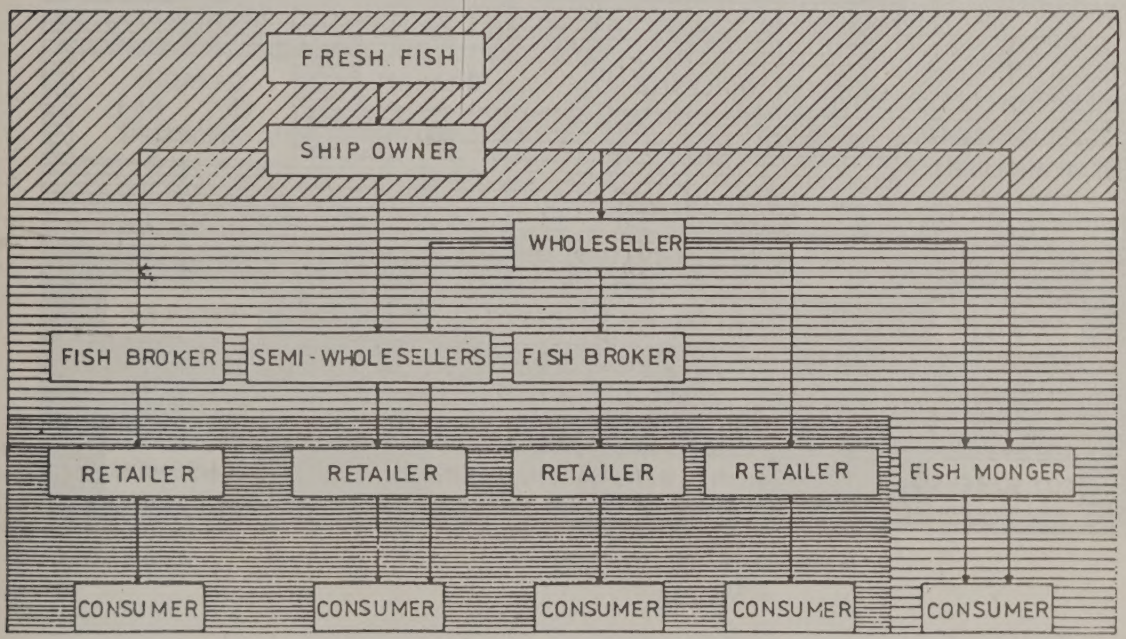
SCHEME 1

DISTRIBUTION PATTERN OF FRESH FISH

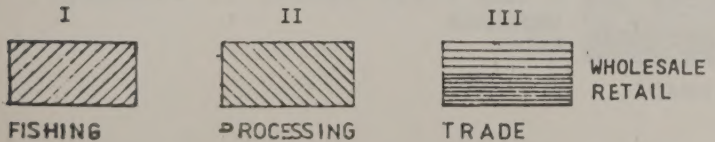
ARTISANAL FISHERIES



SEMI-INDUSTRIAL FISHERIES

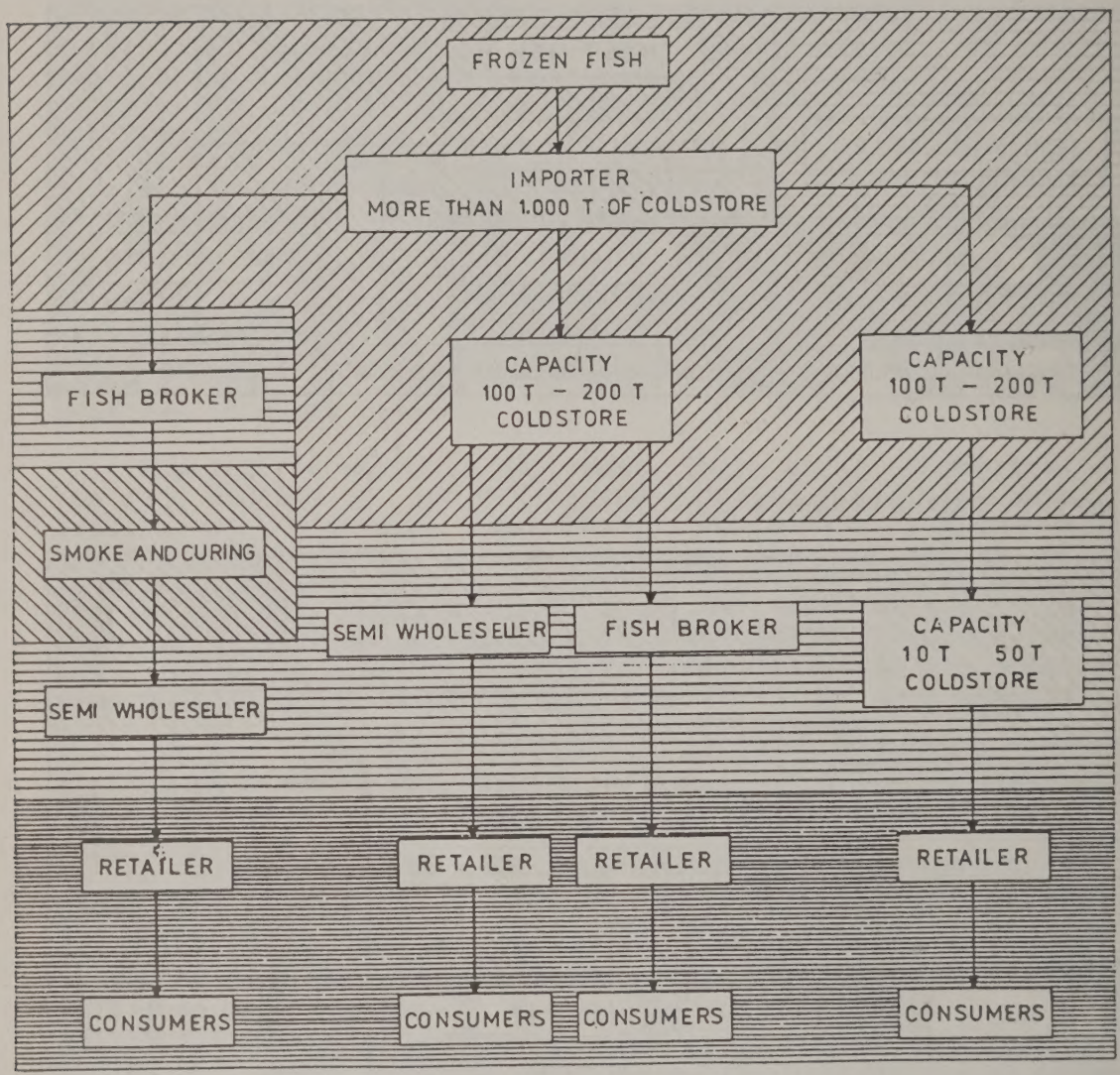


SOURCE : ORSTC NOUVELLE SERIE n° 40, MAI 1975



SCHEME 2

DISTRIBUTION PATTERN OF IMPORTED FROZEN FISH



SOURCE : CECAF PROJECT – 1976

I GAIN SECTOR

II PROCESSING

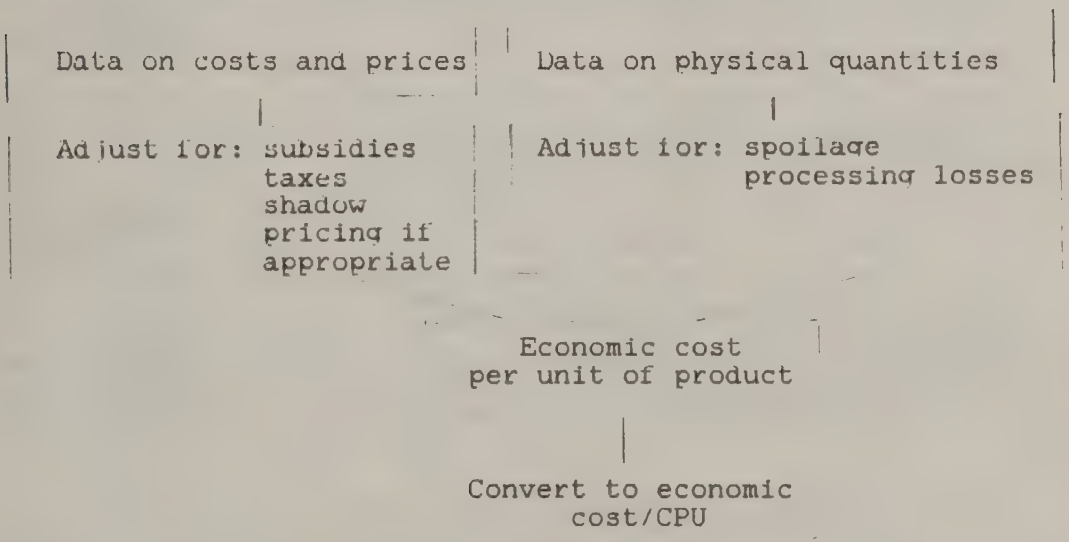
III TRADE

WHOLESALE
RETAIL

artisanal, semi-industrial and import. The complexity is readily apparent and here the approach to data collection could obviously involve collecting both processing and production cost data and market price data. Even within the three sub-sectors identified there are variations which would need to be taken into account, depending of course, on the availability of data and the budget for the study.

There are situations where an analysis of comparative protein costs at only the primary (Sector 1) stage might be more practical, for example, in an economy where the two principal sources of high protein food are beef and fish, where the animals and fish are sold direct to final consumers without intermediate processing. Such could be the case in an Islamic state in northern Africa, for example. The straight comparison of costs on a live weight basis, converted directly to protein units, could be attempted in a meaningful way. However, such a case would be unusual, and where a comprehensive analysis in terms of final products purchased by the consumer is the desired objective, several additional steps are required.

The final measure of costs per equivalent protein units requires two ingredients: a measure of costs and a measure of physical units. Both must be derived by making a series of adjustments from the raw data. These adjustments may be summarized schematically as follows:



It should be noted that the technical coefficient (1.667 in the example on next page) cannot be provided in standard tables and will need to be researched locally. The EPP measure shown in the appendices is only a measure of protein content, not of weight loss in processing. However, Appendix 1, Tables 3,4,5 and 6 may be helpful.

The following numerical example may serve as an illustration:

EXAMPLE OF ANALYSIS PROTEIN COST FOR PROCESSED FISH

		In raw material Units	In terms of unit Final product
	Sector I (Production)		
a.	Direct costs of fishing	2.00	
b.	Fishing overheads and profits	.20	
c.	Total fishing costs	2.20 1/ X 1.667 2/	= 3.665
	Sector II (Processing)		
d.	Cost of fish for processing	2.20	3.665
e.	Losses due to spoilage (add 25% to d)		.916
f.	Direct processing costs		2.009
g.	Processing overheads and profits		.660
h.	Total processing costs		7.250
	Sector III (Marketing)		
i.	Cost of processed product		7.250
j.	Cost of storage and distribution		2.000
k.	Losses due to spoilage (add 14.3% to g & i)		1.037
l.	Profits and overheads in marketing		1.030
m.	Price to consumers		11.317

In this example, therefore, the cost of US$11.317/unit of processed product is made up as follows:-

	US$/unit
Cost of raw fish successfully processed	3.665
Cost of losses during processing (e)	.916
Processing cost (f & g)	2.669
Cost of losses in distribution (k)	1.037
Distribution and market costs (j & l)	3.030
	11.317

1/ Price/unit of fish sold

2/ Technical coefficient representing amount of raw material weight required to produce the same weight of finished product, without allowing for "avoidable losses" (spoilage).

In terms of the physical quantity of fish the calculation may be followed thus:-

(a)	Quantity of fish landed	100 units
(b)	Technical conversion factor	1.666
(c)	Quantity of end-product potentially produced (a divided by b)	60.02 units
(d)	Losses during spoilage (25% of c)	15.01
(e)	Quantity sold to marketing sector	45.01
(f)	Losses in storage distribution etc (14.3% of e)	6.44
(g)	Quantity sold to consumers	38.57

The next step is to adjust these cost elements/units for any economic distortions so that unit costs for fish may be compared with unit costs of other high protein foods, such as poultry, beef, pork or milk. For example, there may be a tax on the fuel purchased by the distribution company (but not, say, a tax on fuel purchased by fishermen). Thus a reduction should be calculated and applied to cost item j. If the Government provides free fishing gear to fishermen, fishing costs should be adjusted accordingly. In some countries where detailed economic accounting prices are available, it would be possible to convert all the cost elements to adjusted figures, thereby taking into account any foreign exchange adjustments or a lower opportunity cost of labour where there is significant under- or unemployment. No examples of such adjustments are given here to avoid complications.

Thus it is a straightforward step finally to convert US$ 11.317/unit of final product to its equivalent value per unit of protein. Let us assume that the product concerned is filleted cod (see Appendix 2, table 1, item II). The conventional protein unit content of filleted cod is 17%; therefore to obtain one unit by weight of CPU it would cost US$ 66.571 (11.317 divided by .17).

Looked at another way, to produce one ton of CPU by means of producing filleted cod available for consumers would require (100 divided by .17) = 5.88 tons of filleted cod, which would in turn require (100 divided by 38.57) X 5.88 = 15.25 tons of landed fresh cod.

Since filleted cod is 100 % protein (it contains no fat or inedible parts), no purpose is served by estimating EPP. The ratio of CPU:EPP in the third column is a measure of the "richness" of the protein. The CPU is a measure of the proportion of protein in the final product, whereas EPP is a measure merely of the protein content of the final product; this is not surprisingly higher in processed products than in unprocessed products as can be seen from the tables.

APPENDIX 1

Table 1: Protein parts content and conventional protein units content in various species of fish - in % of wet weight

No.	Specification	EPP	CPU	CPU:EPP
I.	Polish catches[1/]			
1.	Cod (Gadus morhua)	65.00	11.05	17.00
2.	Herring (Clupea harengus)	62.00	11.16	18.00
3.	Sprat (Sprattus sprattus)	62.00	11.16	18.00
4.	Plaice (Pleuronectidae)	41.00	6.55	16.00
5.	Mackerel (Scomber scombrus)	63.00	13.23	21.00
6.	Horse mackerel (Trachurus trachurus)	41.00	7.79	19.00
7.	Antarctic fish	55.00	10.45	19.00
8.	Other	42.00	7.14	17.00
9.	Cephalopods	42.00	7.14	17.00
II.	Indian Ocean[2/]			
1.	Mackerel scad (Decapterus macarellus)	56.40	11.84	21.00
2.	African scad (Trachurus delagoa)	61.80	11.80	19.10
3.	Arabian scad (Trachurus indicus)	64.80	13.60	21.00
4.	Blacktip sardinella (Sardinella melanura)	72.70	12.64	17.40
5.	Silver grunt (Pomadasys argenteus)	62.60	11.89	19.20
6.	Chub mackerel (Scomber japonicus)	57.70	12.69	22.00
7.	Indian mackerel (Rastrelliger kanagurta)	66.50	13.96	21.00
8.	Bluefish (Pomatomus saltatrix)	61.80	12.91	20.90
9.	Indian snapper (Lutjanus sanguineus)	62.80	13.31	21.20
10.	Red snapper	63.70	14.01	22.00
11.	Longface emperor (Lethrinus elongatus)	59.00	12.98	22.00
III.	Southeast Atlantic			
1.	Cape hake (Merluccius capensis)	70.65	12.01	17.01
2.	Kinglip (Genypterus capensis)	60.00	10.62	17.70
3.	Cape horse mackerel (Trachurus capensis)	55.06	10.46	19.00
4.	Atlantic cutlassfish (Trichiurus lepturus)	70.14	-	-
5.	Chub mackerel (Scomber japonicus)	66.00	14.65	22.20

APPENDIX 1

(Table 1 continued)

No.	Specification	EPP	CPU	CPU:EPP
III.	Southeast Atlantic (continued)			
6.	John dory (Zeus faber)	51.19	-	-
7.	Common seabream (Pagrus pagrus)	58.10	-	-
8.	European conger (Conger conger)	71.02	-	-
9.	Snoek (Thyrsites atun)	70.33	-	-
10.	Swordfish (Xiphias gladius)	70.65	-	-
11.	Slender alfonsino (Beryx splendens)	48.60	8.62	17.75
IV.	Southeast Pacific			
1.	Lorma	53.10	9.23	17.40
2.	Hake (Merluccius)	56.00	9.07	16.20
3.	Cochinopa	52.40	8.28	15.80
4.	Sardinops	59.20	12.08	20.40
5.	Horse mackerel	64.00	12.22	19.10
6.	Mackerel	66.00	13.79	20.90
V.	North Atlantic			
1.	Blue whiting (Micromesistius poutassou)	61.10	10.85	17.76
2.	Grenadier (Macrurus rupestris)	38.00	6.76	17.80
3.	Atlantic halibut (Hippoglossus hippoglossus)	70.00	8.40	12.00
4.	Atlantic redfish (Sebastes marinus)	53.00	9.43	17.80
VI.	Northeast Pacific			
1.	Alaska pollock (Theragra chalcogramma)	62.60	10.89	17.40
2.	European hake (Merluccius merluccius)	56.00	9.69	17.30
VII.	Baltic			
1.	Plaice (Pleuronectidae)	72.60	12.19	16.80
2.	Mackerel (Scombridae)	61.00	12.20	20.00
3.	Herring (Clupeidae)	60.50	10.53	17.41

1/ Source: Polish researches 1983

2/ Source: Bulletin of Sea Fishery Institute 6/56 Gdynia 1979

APPENDIX 1

Remarks

The amount of edible parts presented in the table is based on Polish and European food customs. The question as to what is and what is not edible is, to a large extent, one of custom. It is quite probable that in a number of developing countries certain parts of fish regarded as non-edible according to European standards, and presented as such at table,may be considered as edible. Some limited information available on the manner of preserving, processing and also eating fish in Africa and certain Southeast Asian countries indicates that such is the case. That is why the category "edible parts" should be based on food customs of a given country. The authors are of the opinion that there will be a considerably larger amount of edible parts in the body of the fish in non-European countries.

Table 2: Calculation scheme of protein edible parts and conventional protein units in agriculture - in % of liveweight

Species	Live weight	Carcass	Edible offals	Together (3 4)	Fats	Carcass bones	Feet and head bones	Together (6 7 8)	EPP (5-9)	CPU	CPU:EPP
1	2	3	4	5	6	7	8	9	10	11	12
Cattle	100.00	49.00	7.73	56.73	3.03	10.05	2.20	15.28	41.45	7.42	17.90
Goats	100.00	54.00	14.35	68.35	3.58	10.05	2.20	15.83	52.52	7.72	14.71
Sheep	100.00	50.07	9.00	59.07	3.58	9.26	2.20	15.04	44.03	6.47	14.71
Pigs	100.00	72.10	8.91	81.01	13.94	6.13	2.22	22.29	58.79	3.45	12.20
Poultry	100.00	75.00	-	-	-	-	-	-	48.34	6.05	12.53
Eggs	100.00	-	-	-	-	-	-	-	88.60	9.75	11.01
Milk	100.00	-	-	-	-	-	-	-	100.00	2.99	2.99

The percentage share of the weight of carcasses, edible offals, fats, carcass bones and head bones for the various animal species in a given country may differ from the model calculation presented in these tables which are based on averages, calculated in Tables 3, 4, 5 and 6. The analysis of the possible range of differencies is described further on. For this reason, before commencing on calculations with regard to a given country, it is recommended that a calculation be made using the above scheme of actual animal species and types of production.

Table 3: Liveweight, carcass weight, edible offals and fats - AFRICA

CONTINENT COUNTRY	CATTLE							GOATS							SHEEP						
		CARCASS		EDIBLE OFFALS		FATS			CARCASS		EDIBLE OFFALS		FATS			CARCASS		EDIBLE OFFALS		FATS	
	Live weight in kg	weight in kg	weight in % 1/	weight in kg	weight in % 2/	weight in kg	weight in % 2/	Live weight in kg	weight in kg	weight in % 1/	weight in kg	weight in % 2/	weight in kg	weight in % 2/	Live weight in kg	weight in kg	weight in % 1/	weight in kg	weight in % 2/	weight in kg	weight in % 2/
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
AFRICA																					
Cameroon																					
Cattle	-	150	-	30.0	20.7	4.5	3.0	-	-	-	-	-	-	-	20.0	10.0	50.0	2.0	20.0	0.3	3.00
Dahomey																					
Ox	320	150	47.0	18.2	12.1	-	-	29.0	13.0	44.8	8.0	17.85	-	-	16.0	7.5	46.0	1.6	21.33	-	-
Cows	265	120	45.0	17.0	14.2	-	-	8.0	4.0	50.0	-	-	-	-	8.0	4.0	50.0	-	-	-	-
Ghana																					
	-	110	-	24.2	22.0	2.2	2.0	-	9.14	-	2.5	22.0	0.23	2.0	20.5	10.0	48.7	2.2	22.0	0.2	2.0
	-	-		-	-	-	-	-	11.5	-	-	-	-	-	-	-	-	-	-	-	-
Guinea																					
	-	100	-	20.0	20.0	-	-	-	11.0	-	-	-	-	-	-	12.0	-	-	-	-	-
Ivory Coast																					
	200	90	45.0	25.0	27.7	-	-	20.0	10.0	50.0	-	-	-	-	-	7.5	-	-	-	-	-
	230	120	50.0	-	-	-	-	-	-	-	-	-	-	-	-	14.0	-	-	-	-	-
Liberia																					
	-	100	-	18.0		2.0	2.0	-	9.0	-	1.6	17.77	0.20	2.22	-	10.0	-	1.8	18.0	0.2	2.0
Madagascar																					
Zebu	300	140	47.0	28.0	20.0	4.2	3.0	-	13.0	-	-	-	-	-	23.0	-	-	-	-	-	-
Cows	260	135	-	-	-	-	-	-	-	-	-	-	-	-	50.0	-	-	-	-	-	-
Ox	380	195	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Marocco																					
	240	115	50.0	19.8	16.5	2.5	2.17	20.0	10.0	46.0	-	-	-	-	25.0	12.0	50.9	1.8	15.0	0.4	3.33
Mauretania																					
Zebu	300	135	45.0	40.0	29.7	2.3	1.70	25.0	12.0	40.0	-	-	-	-	30.0	15.0	45.0	-	-	-	-
Goubra	300	136	42-50	40.0	30.8	2.8	1.91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mozambique																					
Cattle	-	170	-	20.2	11.9	7.1	4.17	-	11.0	-	-	-	-	-	-	12.0	-	1.7	14.16	-	-
	-	70	-	3.4	4.9	2.9	4.14	-	4.5	-	-	-	-	-	-	-	-	-	-	-	-
Namibia																					
Cattle	329	164	50.0	-	-	-	-	-	-	-	-	-	-	-	39.0	19.0	49.0	-	-	-	-
Nigeria																					
North	227	113	49.0	28.2	25.0	-	-	23.2	10.5	45.2	-	-	-	-	27.2	13.9	51.0	-	-	-	-
East	213	114	53.5	25.5	22.3	-	-	16.3	7.4	45.1	-	-	-	-	17.3	8.8	51.0	-	-	-	-
West	252	136	54.0	34.0	25.0	-	-	16.1	7.3	45.0	-	-	-	-	18.7	9.6	51.0	-	-	-	-
Senegal																					
	-	120	-	-	-	-	-	25.0	14.0	49.0	-	-	-	-	30.0	14.0	50.0	-	-	-	-
Sierra Leone																					
	-	110	-	27.5	40.0	3.3	3.0	-	-	-	-	-	-	-	-	11.0	-	-	-	-	-
Sudan																					
Cattle	-	175	-	35.0	19.98	5.25	2.98	-	13.0	-	2.6	20.0	0.39	3.00	-	18.0	-	3.8	20.0	0.54	3.0
Camels	-	275	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanzania																					
	215	107	50.0	16.6	15.51	2.20	2.61	20.0	12.0	60.0	4.8	40.0	9.36	3.00	20.0	12.0	60.0	4.8	15.0	0.36	3.0
Togo																					
	-	78	-	-	-	-	-	12.0	7.5	62.5	-	-	-	-	16.0	9.5	59.3	-	-	-	-

1/ Carcass weight in % of liveweight. 2/ Edible offals and fats in % of carcass weight.

Table 4: Liveweight, carcass weight, edible offals and fats - ASIA, SOUTH AMERICA, AVERAGE AFRICA AND WORLD

CONTINENT COUNTRY	CATTLE							GOATS							SHEEP						
		CARCASS		EDIBLE OFFALS		FATS			CARCASS		EDIBLE OFFALS		FATS			CARCASS		EDIBLE OFFALS		FATS	
	Live weight in kg	weight in kg	weight in % 1/	weight in kg	weight in % 2/	weight in kg	weight in % 2/	Live weight in kg	weight in kg	weight in % 1/	weight in kg	weight in % 2/	weight in kg	weight in % 2/	Live weight in kg	weight in kg	weight in % 1/	weight in kg	weight in % 2/	weight in kg	weight in % 2/
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
ASIA																					
Burma	-	120	-	30.0	25.00	2.4	2.00	-	-	-	-	-	-	-	-	12.0	-	2.4	20.00	0.25	2.0
Ceylon																					
Cattle	152	68	44.7	19.0	20.5	2.0	2.94	-	-	-	-	-	-	-	20.5	9.5	48.3	-	-	-	-
Buffalo	330	147	44.8	17.0	11.6	5.0	3.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-
India	-	76	-	10.0	13.1	2.48	3.26	15.0	9.0	60.0	2.0	22.22	0.45	5.00	-	9.0	-	2.0	22.22	2.75	9.48
Buffalo	-	132	-	13.0	9.8	3.92	2.96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indonesia																					
Ox	325	163	50.0	15.0	9.2	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cows	265	125	47.0	13.0	10.4	-	-	26.8	12.4	46.0	-	-	-	-	25.3	11.2	44.0	1.9	17.0	-	-
Buffalo	397	189	46.0	13.0	7.1	-	-	-	-	-	-	-	-	-	19.5	8.6	44.0	1.8	21.0	-	-
Japan	405	233	53.0	-	-	-	-	20.0	13.0	45.0	-	-	-	-	42.0	21.0	50.0	-	-	-	-
Pakistan																					
Cattle	225	90	40.0	-	-	-	-	16.7	10.0	60.0	-	-	-	-	16.7	10.0	60.0	-	-	-	-
Buffalo	412	165	40.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Philippines																					
Cattle	300	145	48.3	14.5	10.0	-	-	25.0	15.0	59.0	1.5	10.0	-	-	20.0	12.0	55.0	1.2	10.0	-	-
Buffalo	350	170	48.5	17.0	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SOUTH AMERICA																					
Argentina																					
Cattle	345	265	59.0	37.5	14.1	36.0	13.58	44.0	23.0	50.0	3.2	13.01	3.0	13.4	44.0	23.0	52.2	3.2	13.9	3.00	13.0
Ox	560	325	58.0	26.5	8.1	30.0	9.23	32.0	16.0	50.0	1.9	5.93	0.5	3.12	32.0	16.0	50.0	1.9	11.3	0.50	3.1
Cows	400	192	48.0	31.6	16.6	37.0	19.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brazil																					
Ox	420	220	53.28	38.9	47.7	16.5	7.51	-	-	-	-	-	-	-	40.0	21.5	53.7	6.1	28.51	1.55	7.20
Cows	350	185	52.86	30.0	16.2	14.0	7.56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Colombia	220-230	132	60.00	-	-	-	-	-	-	-	-	-	-	-	13.0	7.1	54.8	-	-	-	-
Ecuador	310	155	50.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mexico	243	162	41.97	-	-	-	-	24.0	14.0	58.3	-	-	-	-	26.0	16.0	61.5	-	-	-	-
Uruguay	420	230	53.0	33.5	14.6	13.4	5.82	-	-	-	-	-	-	-	40.2	18.5	46.0	3.7	20.00	1.10	5.5
Venezuela	310-350	170	44.5	-	-	-	-	-	-	-	-	-	-	-	26.0	16.0	61.5	-	-	-	-
I.Average America	342	173	50.6	22.1	12.25	14.9	7.04	25.1	13.8	55.1	2.15	13.01	1.3	7.02	28.1	14.6	51.2	2.68	18.27	1.52	6.81
II. Average Africa	269	127	48.6	25.1	19.83	3.6	2.94	19.5	10.0	52.9	4.25	23.31	0.3	2.74	24.2	10.8	50.3	2.04	18.95	0.36	3.33
Average World	305	150	49.6	23.6	16.04	9.25	4.99	22.3	11.9	54.0	3.20	18.16	0.8	4.88	26.2	12.7	50.7	2.36	18.61	0.94	5.07

1/ carcass weight in % of liveweight; 2/ edible offals and fats in % of carcass

Table 5: Liveweight, carcass, edible offals and fats - Pigs, Poultry, Eggs and Milk - AFRICA

CONTINENT COUNTRY	PIGS							POULTRY		EGGS				MILK	
	Live weight in kg	CARCASS weight in kg	CARCASS 1/ weight in %	EDIBLE OFFALS weight in kg	EDIBLE OFFALS 2/ weight in %	FATS weight in kg	FATS 2/ weight in %	Live weight in kg	Carcass weight in %	weight of 100 eggs	Number of eggs per layer per year	Hatching rate	Waste rate	Yield for milking animal	Fat content of whole milk
	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
AFRICA															
Cameroon	-	40.0	-	1.6	4.0	2.4	6.0	-	-	4.2	50	-	-	180 320	4.0 4.3
Dahomey	40	28.0	70.0	-	-	-	-	-	-	3.7-8.0	-	-	-	120	-
	53	28.0	52.8	9.6	34.28	-	5.0	-	-	3.5-4.0	-	-	-	-	-
Ghana	-	28.0	-	-	3.0	-	5.0	-	1.2	3.5	50	10	10	55 30	-
Guinea	-	40.0	-	-	-	-	-	-	0.9	3.5	60	20	15	185	5.0
Ivory Coast	50	30.0	65.0	-	-	-	-	1.0-1.5	-	4.0	50	-	-	200	-
Liberia	-	30.0	-	1.5	4.0	2.4	8.0	-	0.75 1.0	4.0 5.0	60 40	10 10	10	100 300 40	-
Madagascar	-	53.0	-	1.0	1.8	2.2	4.0	-	0.80 3.0	3.5 4.0 3.90	30	30	30	700	5.0
Marocco	-	120.0	55.0	-	-	-	-	-	0.80	3.5	80	7	12	500 800	3.3
Mauritania	-	-	-	-	-	-	-	-	0.80	3.5	50	-	-	200	-
Mozambique	-	65.0	-	2.8	4.30	3.1	4.7	-	2.0 6.0	3.0	40	-	-	170	3.6
Namibia	122	91.0	75.0	-	-	-	-	-	-	5.1	-	-	-	-	3.6
Nigeria															
North	90.7	65.3	72.0	3.3	5.05	-	-	1.1	6.7	3.6	70	10	15	900	6.0
East	54.5	35.4	65.0	5.3	11.97	-	-	1.1	0.7	-	-	-	-	30	-
West	59.0	39.4	66.7	5.9	14.97	-	-	1.2	0.8	-	-	-	-	-	-
Senegal	60.0	48.0	80.0	-		-	-	-	-	3.5-4.0	50	-	-	300	5.0
Sierra Leone	-	45.0	-	-	-	-	-	-	0.9	3.8	60	20	15	200	6.0
Sudan	-	-	-	-	-	-	-	-	-	4.5	50	10	10	382	4.0
Tanzania	-	41.0	-	-	-	-	-	-	0.8	-	-	-	-	252 258	2.1 6.0
Togo	-	33.0	-	-	-	-	-	-	-	3.0-4.0	40	20	20	100	4.0

1/ Carcass-weight in % of liveweight. 2/ Edible offals and fats in % of carcass-weight

Table 6: Liveweight, carcass, edible offals and fats - Pigs, Poultry, Eggs and Milk - ASIA, SOUTH AMERICA, AVERAGE AFRICA AND WORLD

CONTINENT COUNTRY	PIGS							POULTRY		EGGS				MILK	
		CARCASS		EDIBLE OFFALS		FATS									
	Live weight in kg	weight in kg	weight in % 1/	weight in kg	weight in % 2/	weight in kg	weight in % 2/	Live weight in kg	Carcass weight in %	weight of 100 eggs	Number of eggs per layer per year	Hatchling rate	Waste rate	Yield for milking animal	Fat content of whole milk
	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
ASIA															
Burma	-	55	-	1.70	3.09	2.20	4.00	-	-	4.5	-	-	-	80	4.5
Ceylon	53.0	36.4	-	-	-	-	-	-	1.0	5.4	60-153	-	-	-	3.8
India	-	29.0	-	4.00	13.70	2.75	94.8	-	-	2.8-5.7	53	-	-	440	7.0
Indonesia	89.0	62.8	71.0	6.39	9.00	-	-	-	-	3.0-3.3	40	65	4	-	-
Japan	80.0	63.0	78.75	-	-	-	-	-	-	5.35	-	65	-	5315	3.32
Pakistan	-	-	-	-	-	-	-	-	-	4.10	-	-	-	-	3.5
Philippines	-	45.0	-	-	-	-	-	-	1.0	5.0 6.5	50-55 135	-	-	400 300	-
SOUTH AMERICA															
Argentina	110.0	90.0	80.0	15.90	17.66	20.00	22.22	-	-	4.5	-	-	-	-	-
	130.0	110.0	70.0	15.60	14.18	26.00	23.63	-	-	-6.0	-	-	-	-	-
	55.0	40.0	72.0	1.75	4.37	9.00	22.50	-	-	-	-	-	-	-	-
Brazil	110.0	81.8	74.36	17.35	21.21	49.50	60.31	3.10	2.4	-	-	-	-	-	3.5-7.6
	125.0	95.5	76.40	20.24	21.19	31.25	38.78	-	-	-	-	-	-	-	-
Colombia	50.0	39.7	79.50	-	-	-	-	2.3 1.8	1.6 1.4	4.5	120-160	-	-	720	3.0-3.25
Ecuador	74.0	48.0	64.86	-	-	-	-	-	1.2	5.8	70	-	-	1000	3.35
Mexico	95.0	65.0	68.42	-	-	-	-	-	-	5.5	-	-	-	-	4.3
Uruguay	91.0	65.5	72.00	6.60	10.07	13.0	19.84	-	-	5.5	-	8-10	-	1400	3.45
Venezuela	95.0	65.0	68.42	-	-	-	-	1.6	1.25	4.6	220	-	-	-	-
	80.0	40.0	50.00	-	-	-	-	-	-	-5.4	-250	6.5	-	620	-
I. Average Asia and S.America	89.8	64.5	71.8	9.94	17.08	19.22	24.30								
II. Average Africa	66.1	47.9	72.4	3.87	8.08	2.52	5.27								
III. Average World	77.95	56.2	72.1	6.95	12.58	10.87	14.78								

1/ Carcass-weight in % of liveweight. 2/ Edible offals and fats in % of carcass-weight

APPENDIX 1

Comments on tables 3-6

Data analysis concerning the relationship of liveweight to carcass weight, edible offals and fat weight in various countries

Cattle

The minimum and maximum weight of cattle and carcass weight in selected Asian, African and South American countries in relation to animal species is as follows:

Continent	Liveweight			Carcass weight		
	minimum	maximum	average	minimum	maximum	average
	kg	kg	kg	kg	kg	kg
Asia and S.America	153	560	342	68	325	173.5
Africa	200	385	269	78	275	127.0
Average World			305			150.0

The share of the carcass weight varies between 40 and 59 percent in liveweight (average for Asia and S. America - 50.65; for Africa - 48.64 percent). From available data, any correlation between the weight of animal and carcass weight is observed. For example, in Pakistan, the carcass share in liveweight is only 40 percent, in spite of the fact that weight of buffalos is higher than the world average. Argentinian oxes, comparable in weight with buffalos, share the carcass weight 59 percent.

Goats

Liveweight of goats varies considerably and ranges from 8 to 44 kg. The Asian and S. American average liveweight is 25.1 kg, and in Africa 19.5 kg. The share of the carcass weight in liveweight differs from 40 percent (Mauritania) to 62.5 (Togo). The average share of carcass weight is 52.9 percent for African countries; the world average 54.0 percent.

Sheep

Liveweight of sheep also varies considerably and its range is similar to goats (from 8.0 to 44.0 kg). The carcass weight is 4.0 to 23.0 kg. The average share of carcass weight in liveweight in Asia and S. America is 51.2 percent and in Africa 50.7.

Pigs

The liveweight of pigs in particular countries varies from 40.0 to 150.0 kg. The average liveweight for Asian and S. American countries is 89.9 kg; for Africa 66.1 kg. The average share of carcass in liveweight for Asian and S.American countries is 71.8 percent and for Africa 72.4 percent.

On the whole it may be considered that for all animal species there is no correlation between the weight of a particular animal and the share of carcass weight. Therefore, applying the continent or world share or world average weight in a given country may not give precise results.

For this reason, when conducting research in a given country, caution in data application when actual data are unknown is recommended. Whenever possible, application of the analytic data would be the best solution.

Relationship of the carcass weight to the weight of edible offals

The weight of edible offals, essential when qualifying the quantity of protein edible parts, expressed by the percentage relationship of edible offals to carcass weight, differs depending on animal species and nutritional habits in a given country.

For example, for cattle, the edible offals weight to carcass weight varies from 4.9 to 40.0 percent; for goats from 5.93 to 40.0 percent; for ovines and sheep from 10.0 to 28.5 percent; and for pigs from 1.8 to 34.3 percent. For this reason the application of the continental average in a given country must be very cautious.

With this remark, the average edible offals percent shares in carcass weight are:

	Cattle	Goats	Sheep	Pigs
Asia and S. America	12.25	10.01	18.27	17.08
Africa	19.63	23.31	18.95	0.08
World average	16.04	18.10	18.61	12.58

Relationship of the carcass weight to fat weight

Similarly, as in the case of edible offals, the relationship of fat weight to carcass weight differs considerably depending on the country and the animal species. For cattle, the relationship of fat weight to carcass weight varies from 1.98 to 19.8 percent; for goats from 2.0 to 13.0 percent; for ovines and sheep from 2.0 to 13.0 percent and for pigs from 4.0 to 60.3 percent.

These latter figures are presented below, bearing in mind the wide range which should lead to caution when using averages.

	Cattle	Goats	Sheep	Pigs
	(..... in % of carcass weight .....)			
Asia and S. America	7,94	7.02	6.81	24.30
Africa	2.94	2.74	3.33	5.27
World	4.99	4.88	5.07	14.87

APPENDIX 2

CONVERSION TABLES OF COMMODITIES ON EDIBLE PROTEIN PARTS AND CONVENTIONAL PROTEIN UNITS

Table 1: Edible protein parts and conventional protein units content in fish products - in % of product sold

No.	Specification	EPP	CPU	CPU:EPP
I.	Frozen and fresh fish			
1.	Cod	62.00	10.50	16.93
2.	Pollock	63.00	10.71	17.00
3.	Blue whiting	63.00	10.71	17.00
4.	Baltic herring	60.00	10.20	17.00
5.	Sardines	70.00	14.00	20.00
6.	Horse mackerel	65.00	12.35	19.00
7.	Flatfish	41.00	6.56	16.00
8.	Mackerel	63.00	12.60	20.00
9.	Antarctic fish	55.00	10.45	19.00
10.	Cephalopods and other	42.00	7.14	17.00
II.	Fillets			
1.	Cod	100.00	17.00	17.00
2.	Herrings	100.00	18.00	18.00
3.	Antarctic	100.00	19.00	19.00
4.	Other	100.00	17.00	17.00
III.	Salted fish			
1.	Herring	65.00	11.70	18.00
2.	Beheaded herring	70.00	12.60	18.00
3.	Other	69.00	12.42	18.00
IV.	Smoked fish			
1.	Hake, cod	62.00	15.06	24.30
2.	Mackerel	79.00	19.98	25.30
3.	Herring, sardine, sprat	58.00	13.63	23.50
4.	Flatfish	80.00	16.00	20.00
5.	Horse mackerel, other	62.00	13.60	21.30
V.	Canned fish			
1.	In oil	80.00	18.00	22.50
2.	In tomatoes	75.00	16.57	22.10
3.	Other	75.00	15.00	20.00
VI.	Marinades	45.00	9.00	20.00
VII.	Ready to serve fish			
1.	Atlantic fish	50.00	10.00	20.00
2.	Baltic fish	50.00	8.00	16.00

APPENDIX 2

Table 2: Edible protein parts content and conventional units content in various kinds of meat in market products - in %

No.	Specification	EPP	CPU	CPU:EPP
1.	Mutton, carcass,medium fat	76.00	12.50	16.44
2.	Mutton, shoulder	85.00	13.30	18.00
3.	Mutton, leg	84.00	15.10	17.97
4.	Veal, carcass, medium fat	77.00	15.20	19.74
5.	Veal, kidney	80.00	15.00	18.75
6.	Veal, leg	79.00	17.20	21.77
7.	Veal, shoulder	77.00	14.90	19.35
8.	Horsemeat, carcass	70.00	15.10	21.57
9.	Pork, carcass,medium fat	88.00	13.60	15.45
10.	Pork, bacon	100.00	10.10	10.10
11.	Pork, shank	71.00	13.70	19.29
12.	Pork, neck	82.00	13.20	16.09
13.	Pork, shoulder	87.00	14.10	16.89
14.	Pork, roast	80.00	16.80	21.00
15.	Pork, ham	83.00	14.40	17.34
16.	Pork, ribs	74.00	11.20	15.13
17.	Beef, carcass, medium fat	84.00	15.60	18.57
18.	Beef, steak	75.00	14.60	19.46
19.	Beef, round	70.00	14.80	21.14
20.	Beef, brisket	82.00	14.80	18.04
21.	Beef, roast	100.00	20.90	20.90
22.	Beef, fillet	100.00	17.40	21.48
23.	Beef, rostbef	81.00	17.40	21.48

APPENDIX 2

Table 3: Edible protein parts and conventional protein contents in main dairy and eggs products - in %

No.	Specification	EPP	CPU
1.	Whole milk	100	3.0
2.	Kefir	100	3.1
3.	Yoghurt	100	3.9
4.	Cottage cheese	100	21.2
5.	Hard cheese	98	25.9-32.0
6.	Dry whole milk	100	25.8
7.	Dry skim milk	100	34.5
8.	Sour cream	100	3.1
9.	Buttermilk	100	3.3
10.	Skimmed milk	100	3.1
1.	Fresh eggs in shell	89	11.4
2.	Fresh eggs - albumen	100	10.8
3.	Fresh eggs - yolk	100	16.3
4.	Dry whole eggs	100	46.8
5.	Dry eggs - albumen	100	85.9
6.	Dry eggs - yolk	100	31.2

APPENDIX 2

Table 4: Edible protein parts and conventional protein units content in various kinds of poultry products

No.	Specification	EPP	CPU	CPU:EPP
1.	Goose, medium fat, whole	42.00	6.80	16.19
2.	Goose, medium fat, disembowled, unfeathered	66.00	10.70	16.21
3.	Goose, fattened, whole	48.00	7.60	15.83
4.	Goose, fattened, disembowled, unfeathered	71.00	11.30	15.91
5.	Pigeon	70.00	15.30	22.14
6.	Turkey, whole	47.00	11.10	23.40
7.	Turkey, disembowled, unfeathered	67.00	15.90	23.75
8.	Duck, whole	48.00	8.50	17.70
9.	Hen, lean, whole	43.00	8.60	20.00
10.	Hen, disembowled, unfeathered	64.00	12.80	20.00
11.	Hen, fat, whole	48.00	8.60	20.00
12.	Hen, fat, disembowled, unfeathered	68.00	12.20	17.94
13.	Chicken, lean, whole	42.00	9.50	22.61
14.	Chicken, lean, disembowled, unfeathered	63.00	14.20	22.53
15.	Chicken, fat, whole	42.00	8.50	20.23
16.	Chicken, fat, disembowled, unfeathered	63.00	12.70	20.15